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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Priority Application Serial No. 09/026,042
Priority Filing Date .... February 19, 1998
Inventor .... Sujit Sharan et al.
Assignee .... Micron Technology, Inc. and Applied Materials, Inc.
Priority Group Art Unit 1763
Priority Examiner .... P. Hassanzadeh, Ph.D.
Attorney's Docket No. MI22-1902
Title: RF Powered Plasma Enhanced Chemical Vapor Deposition Reactor and Methods of Effecting Plasma Enhanced Chemical Vapor Deposition

PRELIMINARY AMENDMENT

To: Assistant Commissioner for Patents
Washington, D.C. 20231

From: Frederick M. Fliegel, Ph.D.
(Tel. 509-624-4276; Fax 509-838-3424)
Wells, St. John, Roberts, Gregory & Matkin P.S.
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Spokane, WA 99201-3817

Sir:

This is a preliminary amendment accompanying a Request for Divisional Application for the above-entitled patent application. Prior to examining the application, please enter the following amendments.

AMENDMENTS

In the Specification

At page 1, before the TECHNICAL FIELD, insert:

CROSS REFERENCE TO RELATED APPLICATION

This patent application is a Divisional Application of U.S. Patent Application Serial No. 09/026,042, filed February 19, 1998, entitled "RF Powered Plasma Enhanced Chemical Vapor Deposition Reactor and Methods of Effecting Plasma Enhanced Chemical Vapor Deposition," naming Sujit Sharan, Gurtej S. Sandhu, Paul Smith and Mei Chang as inventors, the disclosure of which is incorporated by reference. This application is related to U.S. Patent No. 6,159,867, filed August 19, 1999, which is a divisional application of U.S. Patent No. 6,112,697, filed February 19, 1998.

Replace the paragraph beginning on page 11, line 1 to page 12, line 4, with:

In accordance with a preferred aspect of the invention, RF power splitter 36 comprises a center tapped transformer in which the output power provided to the respective first and second electrodes is substantially equal in magnitude. Such is desirable when power splitter 36 is used in connection with the PECVD reactor of Fig. 2. In such circumstances, it has been found that the ratio of power which is applied to the electrodes is related to surface areas 24, 28 of electrodes 22, 26. Hence, by changing or manipulating the subject surface areas, one can manipulate or select the power ratio and affect the magnitudes of the first and second power components which are "seen" by the respective electrodes to which such power components are applied. In the illustrated and preferred embodiment, such surface areas are different from one another, with the susceptor surface area being larger than the shower head surface area. Such enables a power differential to be developed according to a definable relationship. Such relationship consists of a predefined relative magnitude which is directly proportional to the inverse ratio of the 4th power of the areas of the electrodes. Put another way, by varying the relative surface area ratios as between the susceptor and shower head, a variation in power applied thereto can be effectuated. In the illustrated and preferred embodiment, second electrode or shower head 26 has a surface area which is less than or smaller than the surface area of the first electrode or susceptor 22. Such results in a higher magnitude of power

being applied to the shower head than is applied to the susceptor. This advantageously allows deposition of reactants introduced into chamber 21 in a preferred manner by causing highly energetic species to be drawn toward and in the direction of the electrode supporting the workpiece.

In the Claims

Please cancel claims 1-41 without prejudice and add new claims 42-62 as follows:

New Claims

42. A semiconductor processing method of plasma enhanced chemical vapor depositing material over a semiconductor workpiece within a processing chamber comprising:

providing a susceptor electrode having a first effective area A_1, the susceptor electrode being configured to support a workpiece;

providing a showerhead electrode within the chamber operably adjacent the susceptor electrode, the showerhead electrode having a second effective area A_2 that is less than A_1 and being configured to provide gaseous reactants into the chamber, the susceptor and showerhead electrodes constituting the only processing chamber electrodes relative to which a desired bias is to be developed and a plasma processing environment is to be created;

applying RF power to both the susceptor and showerhead electrodes from a single RF power generator, the applied power defining a selected power ratio that is a function of a ratio of electrode areas A_1/A_2 and being split between the susceptor and showerhead electrodes; and

providing at least one reactive gas within the processing chamber effective to chemical vapor deposit a layer of material on a wafer supported by the susceptor electrode within the processing chamber.

43. The method of claim 42, wherein applying RF power comprises providing RF power to each electrode proportional to an inverse of the ratio A_1/A_2 effective to develop a desired bias relative to a semiconductor workpiece supported by the susceptor electrode and to develop a plasma processing environment within the processing chamber.

44. The semiconductor processing method of claim 42, wherein applying RF power comprises:

forming an operative connection between the susceptor electrode, the showerhead electrode, and an RF power splitter;

forming an operative connection between the RF power splitter and the single RF power generator;

splitting RF power supplied by the RF power generator into first and second power components;

applying the first power component to the susceptor electrode; and

applying the second power component to the showerhead electrode.

45. The semiconductor processing method of claim 42, wherein applying RF power comprises:

forming an operative connection between the susceptor electrode, the showerhead electrode, and a transformer having an input side and an output side, the susceptor and showerhead electrodes being operatively coupled with the transformer output side;

forming an operative connection between the transformer input side and the single RF power generator;

splitting RF power supplied by the RF power generator into first and second power components;

applying the first power component to the susceptor electrode; and

applying the second power component to the showerhead electrode.

46. The semiconductor processing method of claim 42, wherein applying RF power comprises:

forming an operative connection between the susceptor electrode, the showerhead electrode, and a transformer having an input side and an output side, the susceptor and showerhead electrodes being operatively coupled with the transformer output side;

forming an operative connection between the transformer input side and the single RF power generator;

splitting RF power supplied by the RF power generator into first and second power components;

applying the first power component to the susceptor electrode;

applying the second power component to the showerhead electrode; and

wherein the transformer output side comprises a plurality of variably groundable coils for enabling the respective magnitudes of the first and second power components to be varied.

47. The method of claim 42, wherein applying RF power comprises providing RF power to each electrode proportional to an inverse of the ratio A_1/A_2 raised to a fourth power effective to develop a desired bias relative to a semiconductor workpiece supported by the susceptor electrode and to develop a plasma processing environment within the processing chamber.

48. The method of claim 42, wherein applying RF power comprises providing RF power to the showerhead electrode proportional to $(A_1/A_2)^4$.

49. A semiconductor processing method of plasma enhanced chemical vapor depositing material over a semiconductor workpiece within a processing chamber comprising:

providing a susceptor electrode having a first effective area A_1 inside the chamber for supporting a workpiece;

providing a showerhead electrode having a second effective area A_2 inside the chamber;

providing a transformer having an input side and an output side, the output side comprising a plurality of coils, one of the coils comprising a center coil;

forming an operative connection between the transformer input side and a single RF power generator, the generator being configured to provide RF power to the transformer input side and comprising the only RF power source which is operably associated with the processing chamber;

forming an operative connection between the transformer output side and the susceptor and showerhead electrodes, said connection comprising the only connection between the transformer and any processing chamber electrode;

grounding one of the transformer output side coils other than the center coil to produce first and second power components which are different in magnitude from one another, the first power component being applied to the susceptor electrode and the second power component being applied to the showerhead electrode, the second power component being related to a power of A_1/A_2; and

providing at least one reactive gas within the processing chamber effective to chemical vapor deposit a layer of material on a wafer supported by the susceptor electrode within the processing chamber.

50. The semiconductor processing method of claim 49, wherein the first power component is greater than the second power component.

51. The semiconductor processing method of claim 49, wherein the transformer is capable of having others of the plurality of output side coils selectively grounded for varying the relative magnitudes of the first and second power components.

52. The semiconductor processing method of claim 49, wherein the second power component is proportional to $(A_1/A_2)^4$.

53. The semiconductor processing method of claim 49, wherein the area A_2 is less than the area A_1.

54. A semiconductor processing method of chemical vapor depositing material over a semiconductor workpiece within a processing chamber comprising:

splitting RF power produced by a single RF power source into first P_1 and second P_2 RF power components of different magnitudes, the single RF power source comprising the only RF power source which is associated with the processing chamber;

powering only two processing chamber electrodes having respective effective areas A_1 and A_2 with the respective different magnitude first and second RF power components, respectively, wherein one of the power components P_1 and P_2 is a function of a ratio A_1/A_2 between the respective effective areas; and

providing at least one reactive gas within the processing chamber effective to chemical vapor deposit a layer of material on a wafer supported by one of the electrodes within the processing chamber.

55. The semiconductor processing method of claim 54, wherein the powering only two processing chamber electrodes comprises:

powering a susceptor electrode having the effective area A_1 with the first RF power component P_1, the susceptor electrode supporting at least one semiconductor workpiece for processing; and

powering a showerhead electrode having the effective area A_2 with the second RF power component P_2, wherein $A_2 < A_1$, the showerhead electrode being powered to a greater magnitude than the susceptor electrode.

56 The semiconductor processing method of claim 54, wherein powering only two processing chamber electrodes comprises powering at least one processing chamber electrode disposed on the exterior of the processing chamber.

57. The semiconductor processing method of claim 54, wherein splitting RF power comprises forming the second RF power component P_2 to be a power of A_1/A_2.

58. The semiconductor processing method of claim 54, wherein powering only two processing chamber electrodes comprises:

powering a susceptor electrode having the effective area A_1 with the first RF power component P_1, the susceptor electrode supporting at least one semiconductor workpiece for processing; and

powering a showerhead electrode having the effective area A_2 with the second RF power component P_2, wherein $P_2 \alpha (A_1/A_2)^4$.

59. A semiconductor processing method of effecting plasma enhanced chemical vapor deposition comprising splitting RF power between only a susceptor electrode and a showerhead electrode, wherein the showerhead electrode has a surface area A_2 smaller than a surface area A_1 of the susceptor electrode, wherein a power component P supplied to the showerhead component is a function of a ratio A_1/A_2 of the areas, the susceptor and showerhead electrodes comprising part of a plasma enhanced chemical vapor deposition reactor from a single RF power generator during deposition, the single RF power generator comprising the only RF power generator which is associated with the reactor.

60. The semiconductor processing method of claim 59, wherein splitting comprises forming the power component P to be $\alpha (A_1/A_2)^4$.

61. The semiconductor processing method of claim 59, wherein splitting comprises forming the power component P to be proportional to a surface area ratio between the susceptor electrode and the showerhead electrode.

62. The semiconductor processing method of claim 59, wherein:

splitting RF power includes splitting the RF power splitter using a transformer including a center tapped secondary winding; and

forming the power component P to be proportional to a surface area ratio between the susceptor electrode and the showerhead electrode.

REMARKS

Claims 1-41 have been canceled and new claims 42-62 have been added. Claims 42-62 are pending in the application. Consideration of the application as amended is requested.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page(s) are captioned "**Version with markings to show changes made**."

The amendments to the specification and new claims 42-62 are supported at least by text appearing at p. 5, line 5 through p. 15, line 19 of the application as originally filed. No new matter is added by the amendments to the specification or by new claims 42-62. New claims 42-62 distinguish over the art of record and are allowable.

This application is believed to be in condition for allowance and action to that end is requested. The Examiner is requested to telephone the undersigned in the event that the next office action is one other than a Notice of Allowance. The undersigned is available during normal business hours (Pacific Time Zone).

Respectfully submitted,

Dated: June 14, 2002

By: [signature]
Frederick M. Fliegel, Ph.D.
Reg. No. 36,138

Version with markings to show changes made.

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Priority Examiner .... P. Hassanzadeh, Ph.D.
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37 CFR §1.121(b)(1)(iii) AND 37 CFR §1.121(c)(1)(ii) FILING REQUIREMENTS TO ACCOMPANY PRELIMINARY AMENDMENT

Deletions are bracketed, additions are underlined.

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END OF DOCUMENT